96-D-111, National Ignition Facility (NIF), Lawrence Livermore National Laboratory, Livermore, California

(Changes from FY 2000 Congressional Budget Request are denoted with a vertical line [|] in the left margin.)

Significant Changes

In response to projected cost increases and schedule delays associated with the Department's National Ignition Facility Project, the Office of Defense Programs, Lawrence Livermore National Laboratory and NIF Project management have been working together to bring the Project back on track as directed by Secretary Richardson. The NIF Project has changed its method of execution to address cleanliness problems in assembling and installing the laser and target system infrastructure. Assembly and installation will be performed by industrial partners with proven records of constructing similarly complex facilities. The project is currently incorporating these changes into a new NIF baseline which will be certified by the Department and submitted to Congress by June 1, 2000. A revised Construction Project Data Sheet will be submitted to Congress with the Secretary's certification of the new NIF baseline. DOE plans to accommodate additional FY 2001 funding needs for the National Ignition Facility which result from the new baseline or related activities, if any, within the budgets for DOE Defense Programs and the Lawrence Livermore National Laboratory.

1. Construction Schedule History

	Fiscal Quarter				Total Estimated Cost ($000)	Total Project Cost ($000)
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		
FY 1996 Budget Request (*Preliminary Estimate*)	1Q 1996	1Q 1998	3Q 1997	3Q 2002	842,600	1,073,600
FY 1998 Budget Request (*Title I Baseline*)	1Q 1996	1Q 1998	3Q 1997	3Q 2003	1,045,700	1,198,900
FY 2000 Budget Request	1Q 1996	2Q 1998	3Q 1997	3Q 2003	1,045,700	1,198,900
FY 2001 Budget Request *(Current Baseline Estimate)*	1Q 1996	2Q 1998	3Q 1997	3Q 2003	1,045,700	1,198,900

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
1996	37,400	37,400	33,990
1997	131,900	131,900	74,294
1998	197,800	197,800	165,389
1999	284,200	284,200	251,476
2000	247,158 [a]	247,158	TBD [b]
2001	74,100	74,100	TBD
2002	65,000	65,000	TBD
2003	8,142	8,142	TBD

3. Project Description, Justification and Scope

The Project provides for the design, procurement, construction, assembly, installation, and acceptance testing of the National Ignition Facility (NIF), an experimental inertial confinement fusion facility intended to achieve controlled thermonuclear fusion in the laboratory by imploding a small capsule containing a mixture of the hydrogen isotopes, deuterium and tritium. The NIF is being constructed at the Lawrence Livermore National Laboratory (LLNL), Livermore, California as determined by the Record of Decision made on December 19, 1996, as a part of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (SSM PEIS).

The mission of the National Inertial Confinement Fusion (ICF) program is to execute high energy density physics experiments for the Stockpile Stewardship program, an important part of which is the demonstration of controlled thermonuclear fusion in the laboratory. Technical capabilities provided by the ICF program also contribute to other DOE missions including nuclear weapons effects testing and the development of inertial fusion power. As a key element of the Stockpile Stewardship Program, the NIF is designed to achieve propagating fusion burn and modest (1-10) energy gain within 2-3 years of full operation and to conduct high energy density experiments, both through fusion ignitions and through direct application of the high laser power. This mission was identified in the NIF Justification of Mission Need, which was endorsed by the Secretary of Energy. Identification of target ignition as the next important step in ICF development for both defense and non-defense applications is consistent with the earlier (1990) recommendation of DOE's Fusion Policy Advisory Committee, and the National Academy of Sciences Inertial Fusion Review Group. In 1995, the DOE's Inertial Confinement Fusion Advisory Committee affirmed the program's readiness for an ignition experiment. A review by the JASONs in 1996 affirmed the value of the NIF for stockpile stewardship.

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[a] Original appropriation was $248,100,000. This was reduced by $942,000 for the FY 2000 rescission enacted by P.L. 106-113.

[b] Revision to the NIF project baseline in progress at present will change the cost estimates for FY 2000 and the outyears. An updated cost estimate will be provided by June 1, 2000, when the Department certifies the new NIF baseline to Congress.

The NIF project supports the DOE mandate to maintain nuclear weapons science expertise required for stewardship of the stockpile. After the United States announcement of a moratorium on underground nuclear tests in 1992, the Department established the Stockpile Stewardship program to ensure the preservation of the core intellectual and technical competencies in nuclear weapons. The NIF is one of the most vital facilities in that program. The NIF will provide the capability to conduct laboratory experiments to address the high energy density and fusion aspects that are important to both primaries and secondaries in stockpile weapons.

At present, the Nation's computational capabilities and scientific knowledge are inadequate to ascertain all of the performance and safety impacts from changes in the nuclear warhead physics packages due to aging, remanufacturing, or engineering and design alterations. Such changes are inevitable if the warheads in the stockpile are retained well into the next century, as expected. In the past, the impacts of such changes were evaluated through nuclear weapon tests. Without underground tests, we will require better, more accurate computational capabilities to assure the reliability and safety of the nuclear weapons stockpile for the indefinite future.

To achieve the required level of confidence in our predictive capability, it is essential that we have access to near-weapons conditions in laboratory experiments. The importance of nuclear weapons to our national security requires such confidence. For detonation of weapon primaries, that access is provided in part by hydrodynamic testing. For secondaries and for some aspects of primary performance, the NIF will be a principal laboratory experimental physics facility.

The most significant potential commercial application of ICF in the long term is the generation of electric power. Consistent with the recommendations of the Fusion Policy Advisory Committee, the NIF will provide a unique capability to address critical elements of the inertial fusion energy program by exploring moderate gain (1 to 10) target designs, establishing requirements for driver energy and target illumination for high gain targets, and developing materials and technologies useful for civilian inertial fusion power reactors.

The ignition of an inertial fusion capsule in the laboratory will produce extremely high temperatures and densities in matter. Thus, the NIF will also become a unique and valuable laboratory for experiments relevant to a number of areas of basic science and technology.

The NIF is an experimental fusion facility consisting of a laser and target area, and associated assembly and refurbishment capability. The laser will be capable of providing an output pulse with an energy of 1.8 megajoules (MJ) and an output pulse power of 500 terawatts (TW) at a wavelength of 0.35 micrometers (μm) and with specified symmetry, beam balance and pulse shape. The NIF design provides an experimental facility to house a multibeam line, neodymium (Nd) glass laser capable of generating and delivering the pulses to a target chamber. In the target chamber, a positioner will center a target containing fusion fuel, a deuterium-tritium mixture, for each experiment. Diagnostics provided by this project will provide the test data to demonstrate subsystem performance and initial operations.

The NIF experimental facility, titled the Laser and Target Area Building, will provide an optically stable and clean environment. This laser building will be shielded for radiation confinement around the target chamber and will be designed as a radiological, low-hazard facility capable of withstanding the natural phenomena specified for the LLNL site. The baseline facility is for one target chamber, but the design shall not preclude future upgrade for additional target chambers.

The NIF project consists of conventional and special facilities.

- Site and Conventional Facilities include the land improvements (e.g., grading, roads) and utilities (electricity, heating gas, water), as well as the laser building, which has an approximately 20,300 square meters footprint and 38,000 square meters in total area. It is a reinforced concrete and structural steel building that provides the vibration-free, shielded, and clean space for the installation of the laser, target area, and integrated control system. The laser building consists of two laser bays, each 31 meters (m) by 135 m long, and a central target area--a heavily shielded (1.8 m thick concrete) cylinder 32 m in diameter and 32 m high. The laser building includes security systems, radioactive confinement and shielding, control rooms, supporting utilities, fire protection, monitoring, and decontamination and waste handling areas. Optics assembly and refurbishment capability is provided for at LLNL by incorporation of an optics assembly area attached to the laser building and minor modifications of other existing site facilities.

  Special facilities include the Laser System, Target Area, Integrated Computer Control System, and Optics.

  - The laser system is designed to generate and deliver high power optical pulses to the target chamber. The system consists of 192 laser beamlets configured to illuminate the target surface with a specified symmetry, uniformity, and temporal pulse shape. The laser pulse originates in the pulse generation system. This precisely formatted low energy pulse is amplified in the main amplifier. To minimize intensity fluctuation, each beam is passed through a pinhole in a spatial filter on each of the four passes through the amplifier and through a transport spatial filter. The beam transport directs each high power laser beam to an array of ports distributed around the target chamber where the frequency of the laser light is tripled to 0.35 μm, spatially modulated by phase plates and focused on the target. Systems are provided for automatic control of alignment and the measurement of the power and energy of the beam. Structural support and auxiliary systems provide the stable platform and utilities required.

  - The target area includes a 10 m diameter, low activation (i.e., activated from radiation) aluminum vacuum chamber located in the Target Area of the laser building. Within this chamber, the target will be precisely located. The chamber and building structure provide confinement of radioactivity (e.g., x-rays, neutrons, tritium, and activation products). Diagnostics will be arranged around the chamber to demonstrate subsystem performance for project acceptance (TEC) and initial operations (TPC). Structural, utility and other support systems necessary for safe operation and maintenance will also be provided in the Target Area. The target chamber and staging areas will be capable of conducting experiments with cryogenic targets. The Experimental Plan indicates that cryogenic target experiments for ignition will be needed 2-3 years after completion of the project. Therefore, the targets and this cryogenic capability will be supplied by the experiments. The NIF project will make mechanical and electrical provisions necessary to position and align the cryogenic targets within the chamber. The baseline is for indirectly driven targets. An option for future modifications to permit directly driven targets is included in the design.

  - The integrated computer control system includes the computer systems (note: no individual computer will cost over $100,000) required to control the laser and target systems. The system will provide the hardware and software necessary to support NIF operations. Also included is an

integrated timing system for experimental control of laser and diagnostic operations. Safety interlocks and access control will also be provided.

- Thousands of optical components will be required for the 192 beamlet NIF. These components include laser glass, lenses, mirrors, polarizers, deuterated potassium dihydrogen phosphate crystals, pulse generation optics, debris shields and windows, and the required optics coatings. Optics includes quality control equipment to receive, inspect, characterize, and refurbish the optical elements.

Project Milestones [a]:

Project milestones for FY 2000 and FY 2001 include:

- FY 2000
  - Complete Optics Facilitization 1Q
  - Complete Switchyard #2 Steel Structures 2Q
  - Certification of new cost and schedule baseline 6/1/00
  - Complete Conventional Construction and commission Switchyard #2 and Laser Bay #2 for installation of Special Equipment: 4Q

- FY 2001
  - Final Safety Analysis Report (FSAR) 3Q
  - End Conventional Construction TBD a

[a] Project milestones and planned completion dates are being reevaluated as part of the baseline revision process.

4. Details of Cost Estimate

(dollars in thousands)

	Current Estimate [a]	Previous Estimate
Design Phase		
Preliminary and Final Design costs (Design Drawings and Specifications)		101,143
Design Management Costs (% of TEC)		21,900
Project Management Costs (% of TEC)		22,000
Total Design Costs (% of TEC)	TBD	145,043
Construction Phase		
Improvements to Land		1,800
Buildings		170,724
Special Equipment		520,802
Utilities		500
Inspection, Design and Project Liaison, Testing, Checkout and Acceptance		73,250
Construction Management (% of TEC)		22,800
Project Management (% of TEC)		31,500
Total Construction Costs (% of TEC)	TBD	821,376
Contingencies		
Design Phase (% of TEC)		1,000
Construction Phase (% of TEC)		78,281
Total Contingencies (% of TEC)	TBD	79,281
Total, Line Item Costs (TEC)	TBD	1,045,700

The cost estimate assumes a project organization and cost distribution consistent with the management requirements appropriate for a DOE Strategic System as outlined in the DOE Order 430.1, Life Cycle Asset Management and the NIF Project Execution Plan. Actual cost distribution will be in conformance with accounting guidelines in place at the time of project execution.

[a] Revision to the NIF project baseline in progress at present will change the cost estimates for FY 2000 and the outyears. An updated cost estimate will be provided by June 1, 2000, when the Department certifies the new NIF baseline to Congress.

5. Method of Performance

The NIF Laboratory Project Office (consisting of LLNL, LANL, SNL, and UR/LLE and supported by competitively-selected contracts with Architect Engineering firms, a Construction Manager, equipment and material vendors, and construction firms) will prepare the design, procure equipment and materials, and perform conventional construction, safety, system analysis, and acceptance tests. DOE will maintain oversight and coordination through the Headquarters Office of Inertial Fusion and the National Ignition Facility Project and the field office. DOE conducted the site selection and the NEPA determination. LLNL was selected as the construction site in the Record of Decision made on December 19, 1996. The method for procurement and installation and testing of special equipment is being reevaluated as part of the baseline revision. Inspection and Title III engineering contracts for the conventional systems will be competitively awarded. NIF start-up will be conducted by the NIF laboratory operations staff.

6. Schedule of Project Funding

(dollars in thousands)

	Prior Years	FY 1999	FY 2000	FY 2001	Outyears	Total
Project Cost [a]						
Facility Costs						
Design	143,043	29,755	TBD	TBD	TBD	TBD
Construction	130,630	221,721	TBD	TBD	TBD	TBD
Total, Line item TEC	273,673	251,476	TBD	TBD	TBD	TBD
Total Facility Costs (Federal and Non-Federal)	273,673	251,476	TBD	TBD	TBD	TBD
Other Project Costs						
R&D necessary to complete construction [b]	85,126	13,909	TBD	TBD	TBD	TBD
Conceptual design costs [c]	12,300	0	TBD	TBD	TBD	TBD
NEPA documentation costs [d]	3,754	601	TBD	TBD	TBD	TBD
Other project-related costs [e]	18,815	1,638	TBD	TBD	TBD	TBD
Total, Other Project Costs	119,995	16,148	TBD	TBD	TBD	TBD
Total Project Cost (TPC)	393,668	267,623	TBD	TBD	TBD	TBD
Budget Authority (BA) requirements						
TEC [f]	367,100	284,200	247,158	74,100	73,142	1,045,700
OPC [g]	132,300	6,800	5,900	5,900	2,300	153,200
Total, BA requirements [h]	499,400	291,000	253,058	80,000	75,442	1,198,900

[a] Prior year actuals are changed to reconcile with DOE Financial Information System (FIS) costs through FY 1999 Revision to the NIF project baseline in progress at present will change the cost estimates for FY 2000 and the outyears. An updated cost estimate will be provided by June 1, 2000, when the Department certifies the new NIF baseline to Congress.

[b] Costs include optics vendor facilitization and optics quality assurance.

[c] Includes original conceptual design report completed in FY 1994 ($12,000,000) and the conceptual design activities for the optical assembly and refurbishment capability and site infrastructure ($300,000).

[d] Includes preparation of the NIF portion of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement and environmental monitoring and permits.

[e] Includes engineering studies (including advanced conceptual design) of project options; assurances, safety analysis, and integration; start-up planning, management, training and staffing; procedure preparation; operating spares; startup; and Operational Readiness Review.

[f] Specific long-lead procurements and contracts (e.g., building construction; major laser, optics, target area special equipment) require BA in advance of costs.

[g] Specific long-lead procurements and contracts (e.g., optics facilitization) require BA in advance of costs.

[h] Represents the current baseline. The revised NIF project baseline will be provided by June 1, 2000, when the Department certifies the new NIF baseline to Congress.

7. Related Annual Funding Requirements

(dollars in thousands)

	Current Estimate [a]	Previous Estimate
Annual facility operating costs [b]	TBD	21,200
Annual facility maintenance/repair costs [c]	TBD	33,200
Programmatic operating expenses directly related to the facility [d]	TBD	61,100
Capital equipment not related to construction but related to the programmatic effort in the facility [e]	TBD	200
GPP or other construction related to the programmatic effort in the facility [f]	TBD	200
Utility costs [g]	TBD	9,000
Other costs [h]	TBD	6,300
Total related annual funding (operating from FY 2004 through FY 2033)	TBD	131,200 [i]

[a] Revision to the NIF project baseline in progress at present will change the current estimate. An updated estimate will be provided by June 1, 2000, when the Department certifies the new NIF baseline to Congress

[b] Includes operator labor, engineering support and materials for upgrades and modifications, and consumables for operation of special equipment.

[c] Includes cost of labor, engineering support, and consumables for special equipment maintenance and refurbishment, including optics. Also includes maintenance for the laser building and support buildings.

[d] Compared to the NOVA experimental program, the annual direct NIF experimental program costs are estimated at $61,100,000 based on use of complex cryogenic targets, increased diagnostics support, and higher levels of three dimensional physics modeling. This primary experimental operating expense will be included in the base Inertial Confinement Fusion Program budget. Additional program costs will be associated with use of the facility.

[e] Fabrication accounts, procurements, such as small lasers and some laser parts, Computer-Aided Design systems, etc. to support upgrades.

[f] Minor additions and modifications to the facility related to programmatic effort.

[g] Electricity only. Gas, sewer, water, etc. are paid out of the General and Administrative budget.

[h] Nitrogen and argon for laser and transport beam tubes, stock inventory, and procurement support.

[i] In FY 2000 dollars.